

Instrumentation for Characterization of Fireballs, Hot Gases, & Aerosols from Defeat of Targets Containing Biological and Chemical Agents

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<http://www.acq.osd.mil/osbp/sbir/solicitations/sbir20152/index.shtml>

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Description:

Testing of methods to defeat chemical and biological agents often requires scaled experiments involving rapid combustion of bio- and chemical- agent simulants. This effort will focus on the development of next-generation instrumentation for effective characterization of physical and chemical processes occurring during rapid combustion in the expanding fireball, to provide quantitative and qualitative data on chemical reactions and physical changes such as particle distribution and fluid flow that result in formation of the final plume. The instrumentation developed must be stand-off or ruggedized to survive the high temperature, high pressure and corrosive/reactive atmosphere created by weapon engagement with a chemical/biological target, and demonstrate repeatable performance under such field conditions. Smaller, agile instruments that can be easily transported from one site to another, requiring minimal utilities (power, water, etc.) and infrastructure at field site, is optimum. In addition, instruments should collect data in a highly dynamic environment where chemical reactions of chemical agents and physical changes such as fluid flow and particle-size redistribution may be occurring at microsecond to millisecond time scales. Specifically we are interested in measuring the following: • Temperature as a function of space and time, • Chemical specie and concentration as a function of space and time and • Droplet/particle velocity and size distribution as a function of space and time. Spatially resolved

measurements, where a single instrument could collect data from multiple positions within or just outside the fireball, are desired. The measurements from these instruments and data obtained from testing will provide the basis for modeling and simulation of the first few seconds of the expanding fireball. Temperature measurements of laboratory scale clean (no agent/simulant/by products or other debris) fireballs have progressed using pyrometry and emission spectroscopy. Species have been measured with mass spectroscopy and other optical techniques and particle size distribution by particle image velocimetry. However these techniques have not scaled up to larger scale up to field scale because of at least two reasons. First the fireball is dirty containing not only detonation products but agent/simulant and byproducts and other debris and second the environment is extremely harsh making instrument survival difficult. PHASE I: Provide proof of concept for next-generation instrumentation for quantitative and qualitative characterization of the physical and chemical process in fireballs. Demonstrate feasibility that new technologies will survive and collect useful data in the harsh environment of explosive fireballs. A proof of concept demonstration shall consist of measuring at least one of the following; temperature as a function of space and time, chemical specie and concentration as a function of space and time and droplet/particle velocity and size distribution as a function of space and time in an explosively generated fireball consisting of explosive detonation products and Triethyl phosphate (TEP), a commonly used simulant. It is anticipated that this would be a laboratory scale test. Technologies of interest include but are not limited to PHASE II: Expand the technology to other relevant agents/simulants. Scale-up, ruggedize and deliver prototypes of instrumentation to demonstrate in relevant testing. Plan and conduct small-scale testing within project scope, and participate in government-provided mid- to large-scale explosives testing. Demonstrate cost-effective data analysis and fast turn-around for repeated testing. PHASE III: Support testing at DTRA Test Division (J9CXT); DTRA Weapons Division (J9CXW) the Army Corps of Engineers, Engineer Research and Development Center (ERDC); Air Force Research Lab (AFRL); Naval Surface Warfare Centers (NSWC); Naval Air Warfare Centers (NAWC); Energetic Materials Research and Testing Center (EMRTC) affiliated with New Mexico Tech; and other laboratories around the country. This technology might also have utility in rocket motor performance instrumentation, or other extremely high rate combustion processes.